Forest Service

Intermountain Region

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File Code: 3420 **Date:** November 12, 2009
Route To:

Subject: Biological Evaluation, Castle Rock Fire, Ketchum Ranger District

To: Forest Supervisor, Sawtooth NF

Enclosed is Forest Health Protection (FHP) Biological Evaluation, BFO-PR-2009-01. Included in this evaluation is general information regarding the biology of Douglas-fir beetle (DFB), including the relationship between Douglas-fir beetle and fire; DFB population monitoring and suppression efforts on Sun Valley Resort and surrounding areas since the Castle Rock Fire; and treatment options and a proposed mitigation strategy to suppress beetle activity for 2010.

If you have any questions, please contact Laura Lazarus at 208-373-4226 in the Forest Health Protection Boise Field Office. For more general information on Forest Health Protection programs and services, visit our combined Region 1 and 4 Web site at: http://www.fs.fed.us/r1-r4/spf/fhp/ or visit our national Forest Health Protection Website at: http://www.fs.fed.us/foresthealth/.

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Enclosure

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BFO-PR-2009-01
Bark Beetle Considerations for Forested Areas Affected by Castle Rock Wildfire
Sun Valley Resort, 2010

by
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The Castle Rock Fire, which burned over approximately 48,000 acres on the Sawtooth National Forest and adjacent State and private lands in late August 2007, left thousands of acres of fire-damaged trees on the landscape. Damage to individual trees ranged from near-total consumption, to that which is barely noticeable. The result is literally hundreds of thousands of trees weakened to some extent—many now much more susceptible to bark beetle attack. Fire-weakened trees may attract a variety of insects dependent upon amount of damage, time of year damage occurs, and insects present in an area. Some damaged trees may be more susceptible to bark beetles than others. Moreover, a few bark beetle species are more inclined to take advantage of such opportunities, often developing populations which may pose threats to adjacent, undamaged stands. The Douglas-fir beetle (DFB) is a bark beetle that is the most likely to develop to that extent in the vicinity of the Castle Rock Fire with the potential for undesirable amounts of tree mortality beyond the fire's boundaries.

Douglas-fir Beetle Biology

Life History. The DFB has one generation each year. Over wintering takes place beneath the bark of the tree in which they developed and occurs mainly as adults. A small percentage may over winter as larvae. Spring emergence of adult beetles varies with location and weather, but usually occurs from mid-April to early June. Beetles that have passed the winter as larvae complete their development in spring and early summer. Those emerge and attack host trees in mid-summer. In addition, a few adults that made initial attacks in the spring may re-emerge to make a second attack in mid to late summer. This second flight (in some years nearly a continual flight) usually accounts for less than 10 percent of the yearly total of attacked trees. Often, these later attacks fill in trees, which were attacked during the initial spring flight.

Identification. Evidence that a tree has been successfully attacked is usually the reddish-brown boring dust found in bark crevices on the lower portion of the tree's bole or on the ground at its base. Wind and rain may *remove* the dust, however, and since attacks are often high on the bole, careful inspection may be required to determine if beetles are present. As a rule, successful attacks can only be confirmed by removing sections of bark to reveal egg galleries, eggs, and/or developing brood.

Distinctive egg galleries are constructed beneath the bark by female beetles as they bore upward through the phloem. Galleries are parallel to wood grain and are commonly 8 to 10 inches in length, usually longer in downed logs. Eggs are laid in nitches alternately along opposite sides of galleries. After hatching, larvae mine outward from, and perpendicular to, the egg gallery as they feed in the phloem.

When the larvae have completed their development, they construct pupal cells at the ends of their feeding galleries. Pupal cells may be well within the bark. Larvae are white, legless grubs; pupae are white to cream-colored. Immature beetles are light brown, becoming dark brown to black, with reddish wing covers, as they mature. Older beetles may be totally black.

Several months after a tree has been attacked, its foliage begins to discolor. Needles first turn yellow, then orange, and finally a reddish brown. Discoloration rate varies with local conditions and individual trees. During dry years, trees fade more quickly, occasionally becoming yellowish-green to orange later the same year they are attacked. Typically, trees begin to fade the year following attack. Tree-to-tree fading also varies with resistance to the staining fungi introduced by the beetles.

DFB Outbreaks After a Fire. DFB outbreaks are typically initiated by some type of stand disturbance, the most common being windthrow, fire, or other weather-related phenomena. Downed trees, logs, or other large-diameter debris are very attractive to Douglas-fir beetles. Beetles attracted to such material are capable of building high populations in a short period of time. New generations emerge and attack susceptible green trees in the surrounding stand. Once an outbreak has started it normally lasts between 3-6 years in an area. Peak attack typically occurs the second year. If other weakening factors, such as defoliation, drought, fire, or root disease are present, the beetle outbreak may be prolonged for several years.

Several conditions must exist for bark beetles to take advantage of fire-damaged hosts. First there must be a sufficient supply of undamaged inner bark in fire-affected trees. If the beetles' food supply, the inner bark (phloem), becomes too dry and darkened—often the case with stand-replacing fires or in thin-barked tree species—beetles can neither feed nor deposit eggs in it. Second, fires must occur at a time when beetles are in the adult stage and can quickly infest susceptible trees. Fires in late summer or early fall may occur after beetles have flown. A recently killed tree's inner bark remains usable to beetles for a relatively short time. If not attacked while still "green," phloem may become too dry, or in some cases "sour," before the next flight season. Third, there must be a population of beetles within a reasonable distance to take advantage of weakened trees, which become available. Because all three conditions must be met for an outbreak to develop, beetle epidemics following wildfires are not a foregone conclusion.

Still, a few such outbreaks are well documented in the Intermountain and Northern Regions (FHP 2000). As documented following the fires of 2000 in Region 1, Douglas-fir beetle readily attacked larger, severely-injured Douglas-fir during the first few years following fires. Several years after the fires, beetles moved into moderately and lightly injured Douglas-fir trees/stands. In approximately 3-4 years following fires, beetles moved into adjacent stands with very few to no fire-injured trees. Beetle activity waned once beetles moved into green, vigorous trees/stands. There are examples of DFB infesting adjacent, standing green trees in an outbreak situation in Idaho (Panther Creek, Salmon NF), Montana and Wyoming (Yellowstone Fire—46 percent mortality in adjacent, uninjured, and standing green trees).

Hood et al. 2007, developed a regression model that can be used by managers to help predict DFB mortality after fire. The model is a guideline that works best if you know how conservative you want to be in predicting trees to die from DFB. Trees that were moderately to heavily scorched on the bole, with around 20-40 percent crown scorch (Hood et al. 2007; Weatherby 1984), are over 15 inches in diameter at breast height (d.b.h.), and are densely stocked are most likely to be attacked by DFB up to 4 years after the fire (Hood et al.).

Natural Control. According to Furniss and Orr (1978), resistance of live trees is the most important natural factor controlling Douglas-fir beetle populations. Trees sustaining physical damage, or ones stressed by drought, defoliation, or disease are most susceptible to beetle attack and the furtherance of an outbreak. By keeping stands in a vigorous condition and removing susceptible trees or downed material, managers can most benefit from this natural resistance factor.

Climate and weather also influence beetle populations. Extremely cold, dry winters would have a detrimental effect on overwintering broods. At the other extreme, droughty conditions stress host trees and favor population buildups.

Naturally occurring parasites and predators play a role in population reduction during non-outbreak conditions, but apparently are not important regulating factors when populations become abnormally high. The most important insect parasite is a Braconid wasp, which parasitizes the beetle's larval stage. Predators include Dolicopdid flies, the larvae of which prey upon beetle larvae; and Clerid beetles, which are predaceous on both the larval and adult stages. Woodpeckers feed on developing larvae higher on the tree bole, where bark is thinner; but their overall effect is probably minimal.

Hazard Ratings

Furniss, and others (1981), identified individual tree susceptibility characteristics as well as those factors that seem to delimit susceptible stands. Trees where attacks are more dense and successful are those that are older, larger, more dominant, and produce more attractant resins.

Several hazard-rating systems have been developed for DFB. Hazard rating provides land managers with a tool to prioritize stands for treatment and identify those that may sustain the highest levels of mortality during a DFB outbreak. High-hazard stands have a **stand basal area >250 feet, a larger plurality of Douglas-fir (>50 percent) are >120 years old and have an average diameter >14 inches** (Weatherby and Their 1993). However, Negron et al. (1999) found that stand basal area was the most significant indicator of mortality during a DFB outbreak. Abiotic agents such as weather patterns (prevailing winds), elevation, aspect (southerly), and position on slope, injury (fire, wind, snow damage, root disease) may also affect beetle populations due to different microsite conditions in which infestations develop.

General Management Alternatives for Mitigating Impacts of DFB Outbreaks

Where infestations occur, it is usually desirable to salvage infested trees. Where management objectives and other resource considerations permit, removing the larger, older component from susceptible stands will significantly reduce future mortality in those and adjacent stands. Existing beetle outbreak(s) may continue for the next 2-3 years--dependent upon weather and our

efforts to reduce both their populations and susceptible hosts. In an attempt to do the latter, there are essentially five alternatives from which to choose. The selection of one or more will be determined by an array of management objectives and opportunities. Alternatives, in decreasing order of site disturbance are:

1. Salvage infested Douglas-fir. This alternative represents the most reliable means of reducing the threat posed by Douglas-fir beetles. Trees need to be removed before overwintering adults emerge from them, which typically occurs in late April (but is weather-dependent and could be from mid-April to late-May). This would produce the most site disturbance, although at least some infested groups may be relatively close to existing roads.

To reduce the susceptibility of stands over the long-term, thinning to reduce the stand basal area is effective during the current outbreak and will reduce the susceptibility of the stand in the future. Trees currently infested with DFB should be removed in the thinning operation. Strictly for reducing beetle hazard, stands should be thinned to 60-80 square feet per acre, if this is compatible with other management objectives. Removing the older, larger Douglas-fir from the stand will significantly reduce future beetle-caused mortality from adjacent less-hazardous stands.

Such activity must be accomplished before they emerge the following spring. If harvest is done during an outbreak, some losses in the largest diameter trees should be expected. All logs should be removed and utilized within 1 year of falling, except those dropped during May, June, and July. These trees can serve as trap trees absorbing beetles from surrounding areas. If logging is planned in one drainage over a multi-year period, it is possible to create a green chain or a continuous supply of down material for beetles to infest.

2. Use of "trap trees". Trap trees refers to either downed green trees dropped early in spring or standing green trees. Either technique will contain beetles in the treated area. Trap trees must be removed as soon as practical following beetle flight to be effective. If the commitment to remove trap trees cannot be made, they should not be installed. To install them, then not remove them, would only exacerbate an already difficult situation. Either application, cutting trap trees or installing tree baits, should be done by about the first of April.

Felled Green Trees. Douglas-fir beetles prefer freshly-downed trees to standing ones. Trap trees can be dropped in late fall. If done sufficiently late, they do not dry significantly before spring. If felled trees are used, they should be cut in groups of 3 to 5 trees. Diameters should be 15 inches or larger. Ideally, the largest, green trees in the stand should be chosen. Trees should be dropped in the shade, and left unlimbed and unbucked. Trees left in the sun, or where a major portion of the bole receives direct sunlight, do not attract beetles nearly as well as those in a shaded environment. Trees could be cut in late fall; but preferably ear1y spring, before April 1. They should be left until about mid-July, if possible. The sooner trees are removed after beetle flight, the better. Certainly they need to be removed before the following April 1.

Standing Green. When harvesting is being contemplated in Douglas-fir stands, pheromone tree baits can be used to stimulate attacks of trees in a specific stand that is scheduled for removal (Gibson and Oakes 1991). This technique is equally effective as a population reduction measure (see above), or as a preventive measure to help remove or 'mop-up' residual populations. This can be very effective in maintaining low beetle populations in areas to be harvested, or in areas adjacent to these disturbed sites. Attractant tree baits can be used in small clearcuts, along rights-of-way, or in any other situation where beetle populations exist or threaten trees and the baited trees are certain to be removed following their attack. Tree baits are sufficiently effective that almost always there is 'spill over" into adjacent unbaited trees. Not only should harvest plans include those trees, but care should be exercised in the use of baits to make sure that beetles do not attack selected leave trees.

Only one entry into a stand is required to cut and remove trees with the standing green, baited tree method. Approximately two standing baited trees, or downed trap trees per acre, dependent upon the size of the infested group, should be sufficient to attract most emerging beetles. Tree baits are best applied in the spring, prior to adult emergence. Trees selected for baiting should also be among the largest, preferably in dense, shaded parts of the stand. They too, should be baited prior to April 1, left in place until after beetle flight, and then removed as soon as possible.

3. Use of pheromone-baited funnel traps. Funnel traps have been used to successfully "trap out" small, isolated populations of beetles in the past; and were used on Tally Lake District in both 1997 and 1998. Not as useful for large or widespread populations, funnel traps can be effective in some situations now existing. They may not be as effective as trap trees or salvage. Traps and attractant pheromone lures are commercially available at a cost of about $40 per set. Traps, placed in clusters of 3-5, near infested groups of trees, would be sufficient to trap most emerging beetles. They need to be installed by about mid-April; and emptied weekly for 6-8 weeks, or until catches cease. Precedence for such treatments was established after the Little Wolf Fire, in 1996 and 1997 ("Bark Beetle Outbreaks Following the Little Wolf Fire," FHP Report 99-7; Gibson, Lieser and Ping; May 1997).

4. *Anti-aggregation pheromone MCH* (based on EPA fact sheet)**.** Methylcyclohexenone, 3-Methyl-2-cyclohexene-1-one, or MCH is an antiaggregation pheromone used to protect live Douglas-fir trees from attacks by Douglas-fir beetles. The beetle produces this pheromone as a means of protecting developing broods from overpopulation in a single tree. Dead and dying Douglas-fir and spruce trees give off a chemical called seudenol that attract beetles to the trees. As the insects gather on dead trees in large numbers, they are stimulated to reproduce. When the number of beetles at a tree reaches a critical density, the beetles then produce methylcyclohexenone (MCH), a pheromone that repels additional beetles and, thereby, protects the food supply needed by the initial beetles and their offspring. The beetles produce the MCH by making a slight chemical alteration in the seudenol, which changes the seudenol from an attractant to the repellent MCH. When small amounts of MCH are attached to dead trees, beetles are prevented from aggregating on the dead trees and from large scale reproduction and reducing the numbers of beetles available to damage healthy trees.

No harm to people or the environment is expected from the approved uses. Toxicity tests show that MCH has very low toxicity. MCH has been used as a beetle repellent for more than 20 years with no reports of adverse effects. Risks to nontarget species are expected to be minimal because MCH shows no adverse effects or very minor effects on nontarget species, and exposure of nontarget species is not expected to occur to any large extent because of the specific, localized method of application. Furthermore, the amount of MCH released from the product is less than would be released naturally from heavily infested trees.

MCH is currently available in two formulations: bubble caps and flakes. The MCH is contained in a polyethylene slow release container that is stapled to dead or dying trees 6-12 feet above the ground. The number of containers used per tree and frequency of application depend on the level of beetle infestation. MCH "bubble caps" can be stapled to trees in a grid pattern throughout the area to be protected. A 12-meter by 12-meter grid is equivalent to 29.6 g. of active ingredient (AI) per hectare, a rate which has been demonstrated effective in the United States. MCH is also available in a flake formulation which can be applied aerially, or from the ground using seed spreaders. Synthetic formulations, aerially applied, have effectively prevented attacks in downed material until it could either be salvaged, or became unattractive as a brood *site* (McGregor, et *aI*, 1984). When fire-damaged trees cannot be timely salvaged, the application of MCH will prevent its colonization by beetles and forestall population increases, which could ultimately threaten adjacent green stands.

MCH bubble capsules are commercially available, and sell for about $1 each, and are used at a rate of 30 per acre. Experimental use within the past several years has shown MCH very effectively reduces beetle-caused mortality in Douglas-fir stands threatened by beetles. We can provide additional information on purchasing and applying MCH if desired. (All pheromone-related products--tree baits, trap lures, anti-aggregants and traps--are available from a couple of sources). We will gladly furnish detailed ordering information if desired.

5. No action. Under this alternative, the potential for beetle populations increasing and killing additional large-diameter Douglas-fir in nearby susceptible stands is high. The amount of standing-tree mortality corresponds to the number of "high-hazard" stands in the general vicinity of ongoing epidemics. While outbreaks typically do not last more than 2-4 years in an area, beetles often kill groups of trees, which may reach several hundred on susceptible sites--drier slopes and ridges containing densely stocked, older, large-diameter Douglas-fir. In general, DFB outbreak trends respond to weather and amount of susceptible hosts nearby.

DFB Management strategies for Sun Valley Resort from 2007 to the present

*Fall 2007 to 2008***.** Bald Mountain is part of the renowned Sun Valley Ski Resort operated under a permit issued to Sun Valley Company. "Central Park" is an ungroomed ski run on Bald Mountain within the Ketchum Ranger District, Sawtooth NF. Central Park earned its name for the widely spaced old-growth Douglas-fir that provides one of the few gladed tree-skiing opportunities for intermediate skiers on Bald Mountain. Central park is about 25 acres in size and has been protected from DFB attack with FHP-funding for the past several years. Bald Mountain was visited by FHP personnel in fall of 2008 and recommended the continuation of MCH treatments at Central Park because of continuing beetle pressure and host tree susceptibility in the area. Aerial detection survey records showed DFB activity within 2 miles of

the resort for several years, indicating there is a viable DFB population nearby. On April 18, 2008, employees from Sawtooth NF and FHP deployed MCH pouches to 30 acres in this area, using a grid strategy of 30 by 30 feet. The cost of this treatment was about $2,500, including MCH procurement and deployment.

A few months after treatment, FHP staff completed walk through visual surveys (Hoffman and Lazarus) to assess any beetle attacks on the backside of Sun Valley resort in the burned area along Warm Springs Road on the west side of the mountain. No attacks were noted during those visits. However, the peak of DFB attacks often occur the second year after a fire (Furniss 1978). Therefore, we recommended treating the Central Park area again in spring 2009. We also recommended treating along Guyer Ridge, where there are thousands of partially damaged and scorched DF trees that remain weakened from the fire and are susceptible to DFB attacks.

The Castle Rock Fire was stopped along several perimeters of the Bald Mountain ski area. Guyer Ridge is one of the fire breaks where backburning was implemented to stop the fire. The backburns got very hot in some places along the resort boundary. Due to the high stand density and large tree size in the unburned areas within the ski area, we recommended treating a buffer strip area (about 200 yards deep) along the burned Guyer ridge to protect the remaining healthy DF. The strategy was to deploy a buffer of pheromone pouches on the edge of the fire area that would interrupt beetle aggregation in that area and prevent them from attacking standing green trees between the Sun Valley Resort's ski runs. The DFB population was thought to be low along Guyer Ridge based on findings of no visible frass on trees by fall 2008 (Hoffman, Jorgensen, and Lazarus).

2009 Spring MCH treatment.
Central Park. The area received the same treatment as in 2008, i.e., 25 to 30 acres were treated with MCH pouches at a cost of $3,000.
Guyer Ridge. The treated area was a 200-300-yard buffer strip along Guyer Ridge east down slope to Warm Springs parking. About 1250 MCH pouches were deployed over about 35 acres in the buffer strip at a cost of $4,500.

Spring 2009 Evaluations. FHP staff conducted visual walkthrough surveys in May and June to monitor DFB flight in the fire area along Warm Springs road (Hoffman and Lazarus). DFB attacks were observed about the first week of June. In walking through several stands—both burned and unburned—we found currently infested, large-diameter, standing Douglas-fir (11-22+ inches d.b.h. Aerial detection survey records from 2009 show a couple of DFB spots of 10+ trees nearby Greenhorn Gulch and west of Warm Springs road. Aerial detection survey is not as reliable a predictor of DFB activity in recently burned areas because it is hard to decipher from the air whether trees are fading due to fire effects or beetles.

DFB Fall 2009 Population Survey.

METHODS

Data Collection

Using ArcMap (V.9.2) and geospatial data, we subdivided the project area into smaller survey units based upon major forest cover types (either DF or DF-SAF), other vegetative characteristics, and landscape features. We then evaluated DFB populations in the area, utilizing one of three different survey methods: (1) walk-through surveys to note the presence and/or absence of current DFB activity; (2) variable radius plot surveys to efficiently delineate and assess large areas with current DFB activity and; (3) fixed 1-acre strip cruises, to obtain a more detailed description of infested stands and to delineate infested area. As previously noted, walk-through surveys were conducted on the backside of Sun Valley Resort in the burned area along Warm Springs road in 2008. Elsewhere on the backside of the resort and in the strips of trees between ski runs, either variable radius plot or strip cruise surveys were employed. This resulted in 18 sampled areas ranging from about 5 to 100 acres in size (Table 1). DFB and stand data were collected from 51 sample points.

From each of the sample points, a variable radius plot (basal area factor 20 or 40) was established to determine sample trees. All trees greater than 5 inches d.b.h. were tallied and measured. Tree mensuration data collected included tree species and d.b.h. All Douglas-fir trees in each plot were examined for evidence of DFB infestation and the type and year of attack was recorded. Tree regeneration less than 5 inches d.b.h., and greater than 6 inches in height was tallied in a $1/100^{th}$ acre fixed radius (9.2-foot) at plot center.

Data Analyses

Data collected in surveyed spruce-fir stands was summarized using the Forest Insect and Disease Tally (FINDIT) program (Bentz 2000). The FINDIT program calculated the following statistics to determine the level of DFB-caused mortality and other stand attributes.

1. Total trees/acre (TPA).
2. Total live and dead basal area (BA ft2/ac).
3. Quadratic mean diameter (QMD).
4. Live stand density index (SDI).
5. Number of dead and live trees.
6. Percentage of each tree species.
7. Percentage of basal area (BA) comprised of each tree species.
8. Total regeneration/acre of each tree species.
9. Percentage of basal area killed by insects and diseases.

RESULTS AND DISCUSSION

As part of the MCH evaluation, FHP (Bennett, Gibson and Lazarus) installed variable radius plots in three locations on the west side of the mountain in the Castle Rock Fire area to sample DFB populations. Robust populations were found in two of the three locations, which prompted additional surveys in this and other areas of concern, including the Sun Valley ski area.

Table 1 summarizes FINDIT results from the 57 plots used to determine the current level of DFB-caused tree mortality in each "stand" and tree mortality trends associated with recent DFB attacks. DF and subalpine fir generally comprised the majority of trees recorded in our survey plots of the Castle Rock fire area, although the proportion of these species varied among stands. Aspen was a minor component in stands 4 and 14 (Figure 1). At the time of the surveys, DFB had attacked trees in 50 percent of the stands sampled.

Figure 1, shows DFB-infested (red) and uninfested (yellow) plot locations in the Sun Valley Resort area. Each variable radius/Findits plot marked on the map represents a swath of trees in the general area, often the area in between ski runs. The longer 1-acre strips cruise plots also represent the general conditions nearby. We conducted walk-through surveys through visual assessments as well along Guyer Ridge and found infested scorched trees scattered all the way down the slope. Randomly-distributed variable radius plots in the same area showed only 5.6 percent of the DF host BAF currently infested, showing that infestations were variable down the slope in the burned area. Visual walk-through surveys were conducted in tree patches between runs adjacent to the most southeastern slope of Guyer Ridge (Figure 1). We did not find any DFB attacks in those trees, but they are highly susceptible to attack next spring based on proximity to attacked trees, size, density, and age. Figure 2 shows where we surveyed DFB populations in the burned areas on the west side of the mountain adjacent to Sun Valley ski resort. Again, "red" plots were infested with DFB and "yellow" plots were uninfested as of August 2009.

In total, we delimited approximately a 900-acre area of currently-infested Douglas-fir on the Sun Valley resort adjacent to the Castle Rock Fire (Figure 1). In total, there are about 2,000 acres of highly susceptible host on the east side of the mountain that includes Sun Valley resort and other public lands represented by Figure 1. There are about 3,000 acres on the backside (west side) of the mountain in and adjacent to the burned areas of highly susceptible host. Again, most of the forested area outside the currently infested zone is considered to be highly susceptible to DFB because of the density, age, diameter, and amount of Douglas-fir available for colonization. Robust populations of DFBs were found scattered all along the burned areas except at our most westerly set of plots, 17, where there was only an endemic population.

The FINDITS model showed that in scorched areas (5, 15, 16, 17, 18), 32.6 percent of trees over 19 inches d.b.h., and 13.3 percent of trees less than 19 inches d.b.h. were heavily attached by DFB in the fire-scorched areas (Figure 1). Additionally, in the four plot sets with current DFB populations in unburned areas (1, 2, 10, and 14), 47.2 percent of trees over 19 inches d.b.h. and 40.9 percent of trees 11 to 19 inches d.b.h. were heavily infested. These heavily attacked trees will likely turn red in summer or fall 2010.

Subalpine fir regeneration was generally most abundant in the understories of sampled stands, although a fair amount of Douglas-fir was also present in some stands. No conifer regeneration was recorded in 55.6 percent of stands represented by variable radius plots (20 and 40 BAF). We did not record regeneration in strip plots. Visual assessments of regeneration outside of plots looked promising for stand replacement. There was regeneration outside of plots in each stand. The regeneration will most likely lead to a heavier SAF component in a mixed conifer stand.

What are projections for the spring population? The DFB population is quite high in and surrounding the Sun Valley ski resort. There are robust populations on the backside of the ski mountain as well as in the burned areas along Guyer Ridge (areas 5, 15, Figure 1) and in the standing green trees in between ski runs. The beetles have already infested a good portion of the trees over 20 inches d.b.h. along Guyer Ridge and areas 1, 2, and 6 (Figure 1). Remaining, suitable trees in the area are in jeopardy of being infested by beetles next spring, simply because of their susceptibility and proximity to existing populations of beetles. The FINDITS model rated all areas we surveyed at **highly** susceptible to DFB, based on density, size, age, and percent of DF host in the area (Table 1). Areas not surveyed but of the same d.b.h., age, percent host, and density characteristics will be highly susceptible to DFB, as well.

Figure 1. DFB surveys were conducted September 2009 in an effort to define population boundaries on the Sun Valley ski resort adjacent to the 2007 Castle Rock wildfire area.

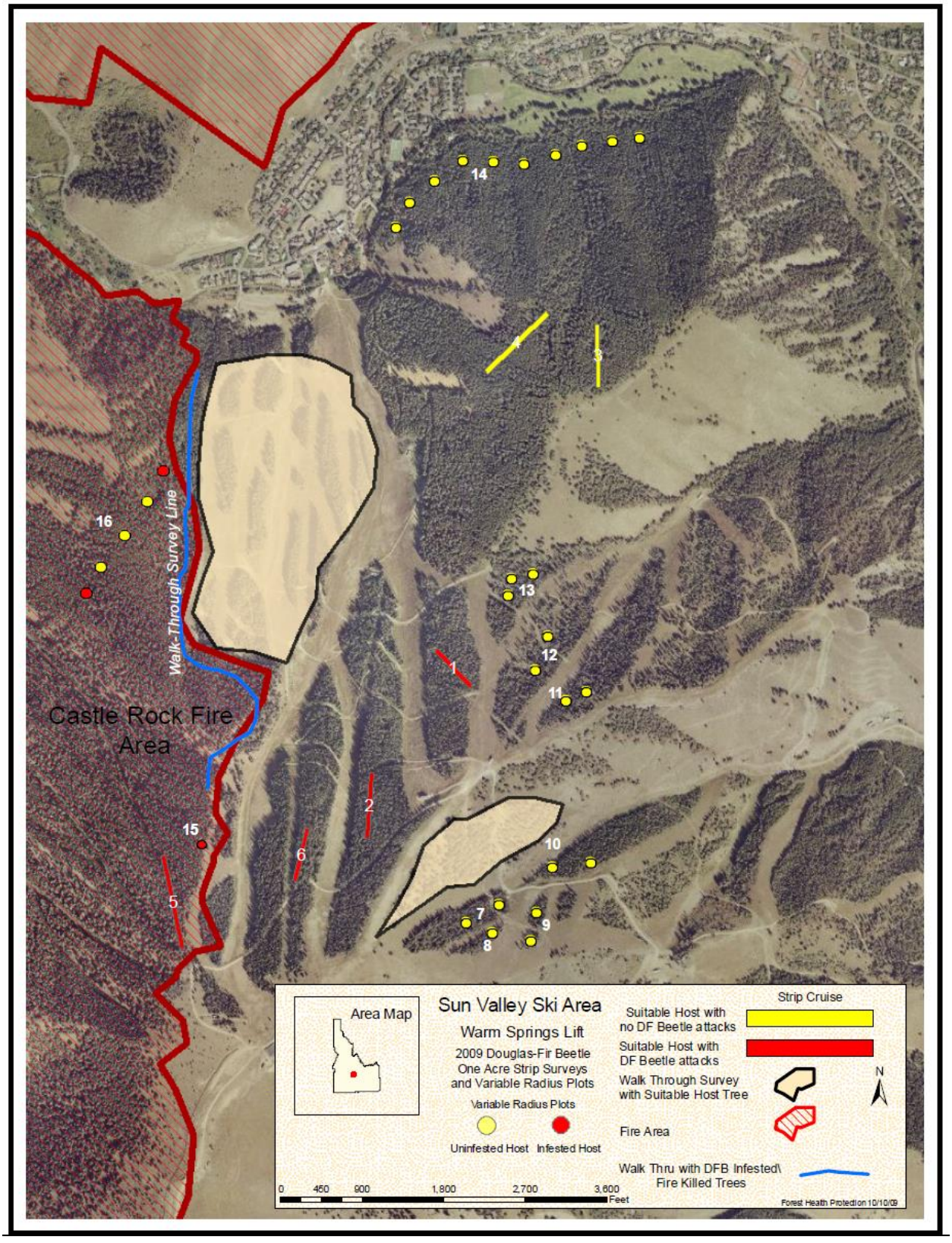

Figure 2. Map of DFB surveys conducted August 2009 on the back side (west) of Sun Valley Ski resort in the Castle Rock fire area.

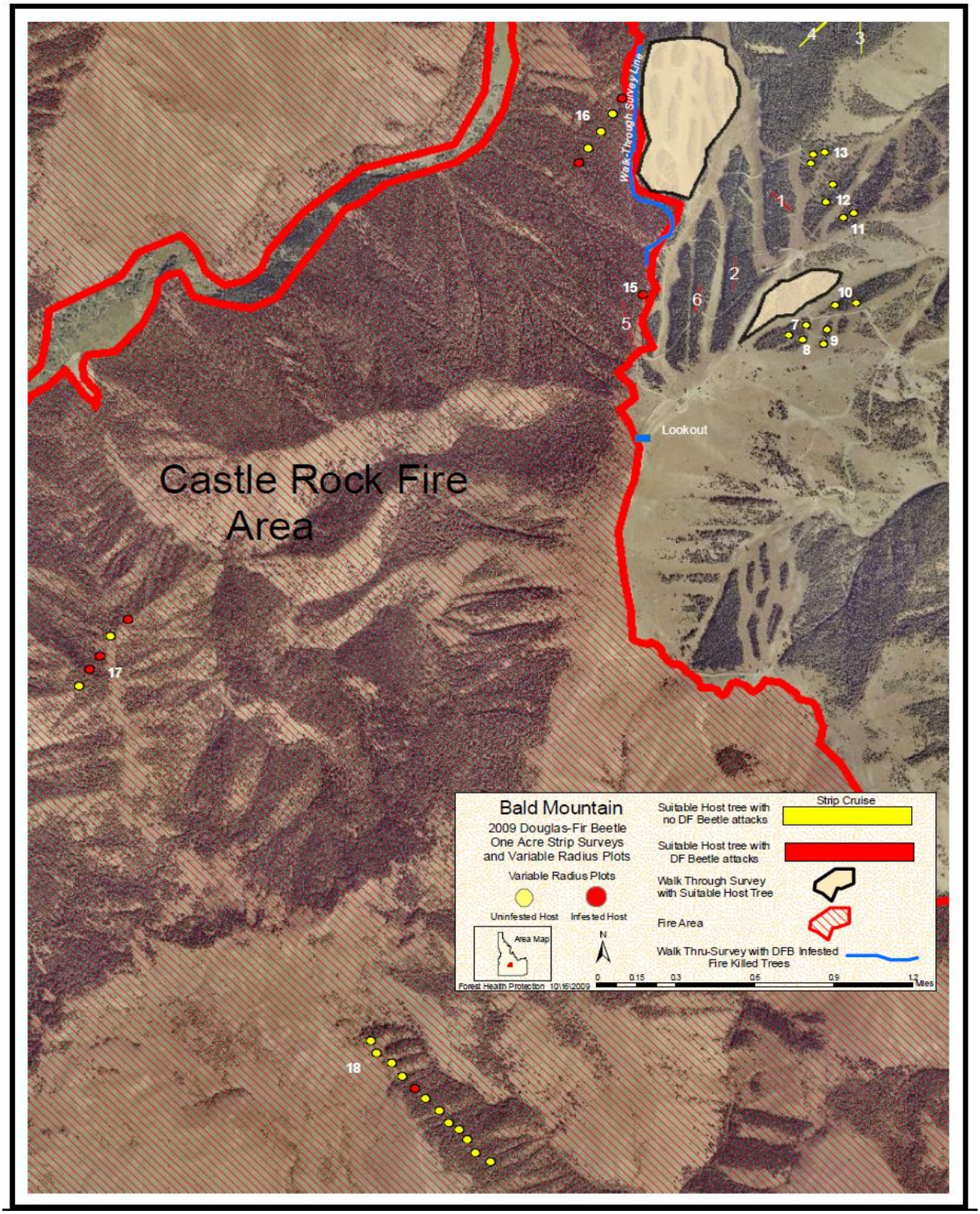

Table 1. Summary of stand attribute data and percent Douglas-fir-infested in each stand surveyed on Sun Valley resort stands and in the 2007 Castle Rock fire area.

Stand	Plot Type	TPA DF	BA Total	Percent Live BA DF	QMD DF	Percent Attacked by DFB	Hazard Rating
1	strip	153	188	90.5	12.3	8.5	High
2	40 BAF	183	160	100	14.2	55.2	High
3	strip	260	125	100	11.7	0	High
4	strip	110	124	96.9	16.0	0	High
5*	strip	250	260	100	16.1	2.1	High
6	40 BAF	123	200	100	17.7	0	High
7	20 BAF	66	206	61.3	19.7	0	High
8	20 BAF	72	140	61.5	19.2	0	High
9	20 BAF	82	140	92.0	14.0	0	High
10	20 BAF	86	220	99.5	12.7	13.5	High
11	20 BAF	25	70	50.0	18.7	0	High
12	20 BAF	199	200	57.1	10.7	0	High
13	20 BAF	67	160	66.7	21.1	0	High
14	20 BAF	297	182	100	12.7	0.7	High
15*	40 BAF	115	92	100	14.3	4.7	High
16*	20 BAF	231	228	100	18.6	32	High
17*	20 BAF	211	176	100	14.6	27	High
18*	20 BAF	159	152	100	17.3	0.7	High

***Castle Rock fire scorch. TA= trees per acre; DF=Douglas-fir; QMD = quadratic mean diameter**

Table 2. Summary of regeneration data and percent DFB-infested in each stand surveyed on Sun Valley Resort grounds and in the 2007 Castle Rock fire area.

Stand	Plot type	Species	TPA DBH 0-2.9"	TPA DBH 3-4.9"
1	strip	NA	NA	NA
2	40 BAF	0	0	0
3	strip	NA	NA	NA
4	strip	NA	NA	NA
5*	strip	NA	NA	NA
6	40 BAF	0	0	0
7	20 BAF	SAF	1100	0
8	20 BAF	SAF	600	0
9	20 BAF		0	0
10	20 BAF	SAF	1050	600
11	20 BAF	SAF&DF	600	0
12	20 BAF	0	0	0
13	20 BAF	SAF	100	0
14	20 BAF	0	0	0
15*	40 BAF	0	0	0
16*	20 BAF	0	0	0
17*	20 BAF	0	0	0
18*	20 BAF	0	0	0

***Castle Rock fire scorch. TA= trees per acre; DF=Douglas-fir; QMD = quadratic mean diameter**

****Regeneration data was not collected on strip cruise plots.**

Specific Recommendations to Mitigate Further Losses from Douglas-fir Beetle Populations on the Sun Valley Resort and in Castle Rock Fire Areas in 2010

A three-part strategy for 2010's DFB mitigation efforts should include: (1) removal of green infested trees in the ski resort areas and also in the back of the resort in the Castle Rock fire area prior to beetle flight next spring; (2) an application of MCH; and (3) baited areas to draw DFB away from high value sites. If infested tree removal is an unacceptable management option, I recommend using a combination approach of MCH and baited areas to protect high value areas from unacceptable Douglas-fir mortality. I recommend applying MCH at least to the largest trees in the Castle Rock fire area and Sun Valley resort area in 2010 because these are the trees that remaining beetles will most likely attack. These are also the trees the resort would like to retain over time. Based on currently high DFB populations in the immediate vicinity and on the high hazard ratings from stand data taken both in the resort area and general forest lands surrounding the resort, no action would very likely result in the continuation of DFB attacking the largest trees first, then moving on to smaller suitable trees. Past outbreaks of this magnitude in Idaho and Montana show that additional tree mortality could then be expected for 1-4 more years. Many areas of the resort side would be left with reduced tree cover due to DFB-caused mortality and the paucity of current tree regeneration. This could adversely affect snow retention and ski run delimination. In other areas, there will still be small mixed conifer trees left to catch snow and to maintain desirable separation between ski runs.

Part one. Prioritize areas to be treated based on stand susceptibility and management goals. The backside of Sun Valley resort should be included in the treatment considerations (infested green tree removal where possible, MCH treatments, and baited areas) because it is the epicenter of the DFB population. It is likely that the DFBs on the back side of Sun Valley were transported by wind and deposited on the front/east side of the mountain. Therefore, you should address the beetle population on the back side of the mountain to prevent large numbers from coming over the ridge and infesting the ski area. It would be prudent to treat all of the burned area on the back side down to plot set 17. MCH treatments on the east side of the mountain (the actual resort area) will serve to protect stands on the ski area from beetles that may be carried in from adjacent areas. Other areas (3, 4, 14) not directly in the ski resort, but part of the valley's viewshed should be given a high priority for treatment as well (Figure 1). Ideally, treat any area where you want to retain large Douglas-fir.

Part two. Deploy MCH, preferably by an aerial application. An aerial application of MCH flakes would work well for this beetle population mainly because of the large potential treatment areas and steep and rugged terrain. Potential treatment areas would be up to 2,000 acres on the front side and 3,000 acres on the back side of the fire-burned areas. Aerial application of MCH flakes over 460 acres post-fire in Washington State cost about $23,000 in 2009. The application was a success, although the beetle population in that area was not as high as the population in and surrounding the Castle Rock fire area (Mehmel, personal communication). Drawbacks of an aerial application of pheromone flakes is that it may elute faster than the pheromone pouch application (55 days of protection with flakes in Washington 2009), and it is an expensive treatment. However, with proper timing of the application, sufficient protection throughout the DFB flight will be possible.

Alternatively, MCH pouches could be deployed by hand but may not be logistically feasible on a large, steep area and may be more expensive to implement than an aerial application. For example, MCH pouch deployment on 650 acres on the Grand Targhee ski resort cost $19,000 in 2009. We know that MCH pouches are very effective, but drawbacks for this type of application include the large number of personnel and man-hours needed to cover this extensive treatment area, expense of hand deployment, and difficulty of deployment associated with spring snow-covered slopes. In all likelihood, either application method would lead to positive results in the treatment areas, but the aerial application would be more efficient, with even coverage, and probably at less cost than would a hand deployment of MCH pouches.

Part three. Bait the beetles away from the ski runs using either trap trees or traps. In conjunction with an MCH treatment, it would be prudent to bait DFBs toward the periphery of MCH-treated areas. We would, in essence, be focusing beetles out of the treated areas toward areas of our choosing that would not be deleteriously affected, or to areas where some Douglas-fir mortality could be tolerated. Bark beetles hone in on the bait, but when populations are this high, some spillover mortality could happen just because of proximity of the population to large, dense Douglas-fir. Baited areas should be within a mile of the treatment area, ensuring that DFB would be able to find them.

Lindgren funnel or panel traps could be used to bait large percentages of beetles into areas of your choosing, thereby limiting spillover of beetles into green trees. Trapping beetles would be an excellent choice for this area, given that it may be hard to remove infested baited trees. A time commitment would be involved to hang and bait traps initially in April and then to empty traps at least once a week through August. Traps could be placed along Warm Springs road, and in areas near access roads on the ski resort, i.e., along Guyer Ridge's most north-burned area to keep the beetles away from ski runs. Successful trapping projects in the past spaced traps three to five chains apart or in clusters in nonhost areas, meadows, or burned sites that contain no green valuable trees. FHP could supply panel traps for this project, or funnel traps can be purchased at $40-45 per trap. Tree baits cost about $7 each.

Part four. FHP will evaluate the efficacy of the treatments in August 2010. Plans for 2011 treatments will be based on 2010 findings. Assuming MCH and baiting strategies work well, treatment acreage in 2011 will likely be reduced and reprioritized.

Concluding Remarks

The application of MCH is appropriate for the short-term protection of trees against beetle attack until stands can be treated silviculturally. It is important to remember that many of these trees are highly susceptible to DFB and, at some point in the future, they may be killed in a natural process of forest renewal. However, the Castle Rock wildfire created a situation that promoted epidemic levels of DFB and DFB-caused mortality. The prioritization of stands for treatment should be based on infested areas, susceptibility of uninfested areas, and resource manager's objectives for the area. DFB populations were still centered in the heavily scorched trees in 2009, and all adjacent, susceptible green Douglas-fir are at risk of attach in 2010. Therefore, treatment blocks should included burned areas if they contain green, live trees deemed valuable.

Keep in mind that this treatment program will involve multiple years of proactive efforts to mitigate impacts of DFB. Also, be aware that, next summer, there will be many DFB-killed trees that will turn red and become highly visible from Highway 75 and Ketchum if they are not removed or cut and left onsite. These trees will eventually turn gray and become less apparent. However, they are currently harboring millions of beetles and these beetles will seek nearby, susceptible live trees to attack next spring.

I hope this information is helpful in selecting a proper course of action. For this situation, a combination of methods will be most effective. That is, an application of MCH should protect high value stands from unacceptable damage. Other concurrent treatments, such as infested tree removal and/or baiting will augment the effectiveness of the MCH treatments. I will continue to work with District personnel in the development and implementation of this treatment program.

I really appreciate all of the support the Ketchum Ranger District, Sawtooth SO, and Sun Valley resort and Boise Field office staffs have given us so far in addressing this DFB situation, including assistance with plot establishment in the fall of 2009. With the help of all of the cooperators, any follow-up treatment program should go smoothly and will undoubtedly minimize the effects of this outbreak.

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